An Integrated Approach to Reducing Agricultural Nutrient Loads in the Harsha Lake Watershed

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For nearly 10 years, members of the East Fork Watershed Cooperative have been working together to monitor and assess the East Fork Little Miami River watershed, including Harsha Lake, a 2,160 acre reservoir that serves as a drinking water source for about half of Clermont County's residents. Partners in the Cooperative include the US EPA Office of Research and Development (USEPA-ORD), the U.S. Army Corps of Engineers, USDA Natural Resources Conservation Service (NRCS), Clermont County's Office of Environmental Quality (OEQ), the Clermont Soil and Water Conservation District (SWCD), and several other organizations. Data collected by the Cooperative suggest that pollutant loads from the watershed are affecting lake water quality in terms of low dissolved oxygen, the prevalence of toxin producing cyanobacteria and the potential for increased disinfection byproduct formation during drinking water treatment.

To minimize cyanobacteria blooms and other issues at the lake, Clermont SWCD, NRCS and other members of the Cooperative work closely with landowners in the watershed, encouraging them to adopt management practices designed to reduce nutrient runoff. In 2011, Clermont SWCD received a Conservation Innovation Grant through the USDA Natural Resources Conservation Service (NRCS) for a project that aimed to demonstrate an integrated agricultural best management practice approach called "cover and capture" in a subwatershed of Grassy Fork, a tributary to the East Fork of the Little Miami River (EFLMR). The "cover" portion of the project involved utilizing cover crops to minimize loss of nutrients from bare fields during the winter months, while the construction of an innovative treatment system based on urban best management practices served as the "capture" component.

As limited funds were available for cover crop incentives, the project team wanted to focus these efforts on fields that contributed the highest nitrogen and phosphorus loads. To accomplish this, the project team utilized the Soil and Water Assessment Tool (SWAT) model developed and calibrated by US EPA-ORD. The SWAT model has been proven to be effective in predicting the impact of point and non point pollution, and various management scenarios on the hydrology, sediment and nutrient loads in watersheds. Model inputs include a digital elevation model (2.5 foot resolution), soils data, land use data and weather data. The Grassy Run watershed was divided into 65 subbasins, which were further divided into hydrological response units (HRUs) based on the soil type, land use and slope derived from the DEM. The management scenario for all agricultural fields was set to a corn-soybean-soybean rotation, with conventional till before planting corn. Fertilizer and herbicide application rates for corn and bean were set based on the recommendation of NRCS personnel. Model runs provided average annual sediment yields for all HRUs was obtained. Yields were plotted in ArcGIS and from this, agricultural parcels with high sediment loadings were located. Clermont SWCD and the NRCS District Conservationist then worked with producers who farmed these fields to secure a commitment to plant winter cover crops for a period of three years. In total,

Clermont SWCD staff collect samples from one of four autosamplers at the capture BMP.

Excavation of AgBMP detention structure.

producers planted over 260 acres in 10 fields located in a small subbasin of the Grassy Fork watershed.

The second component of the grant project involved the construction of an innovative treatment system to "capture" fine sediments and bound phosphorus, while integrating hydraulic retention and biofiltration to add nitrogen removal. The treatment system, completed in 2014, used a combination of management practices more typically found in urban settings, including detention basins and bioretention facilities. To minimize the loss of productive cropland, the treatment system was constructed within the footprint of an existing grassed waterway that drains 180 acres of farmland, bisected by a driveway with twin 30-inch culverts. Above the driveway, the waterway was converted into a linear detention basin. The design consists of a 700-foot trapezoidal waterway with 0.2% minimum slope along an 18-foot wide bottom and side slopes of 3:1. The basin has a storage area of 0.49 acres and holds runoff from a less than 1-inch, 1.4 month storm for up to 24 hours.

Just upstream of the detention basin dam, a six-inch Hickenbottom riser collects water into a six inch PVC pipe that conveys it under the driveway into an off-line "submerged vegetated bed." Flows exceeding the capacity of the basin and the riser overtop the dam, move through the culverts and into the downstream portion of the old waterway which now serves as a bypass channel. The submerged vegetated bed, or SVB, was based on an urban management practice that the University of New Hampshire has been studying called a Submerged Gravel Wetland. This system functions by filtering storm water through a gravel bed that has varieties of wetland plants growing on top to uptake nutrients from the water, much like a hydroponic system. Anoxic conditions in the standing water within the gravel allow for denitrification and the release of nitrogen gas into the atmosphere, thereby increasing nitrogen removal.

The SVB, designed by Clermont SWCD with guidance from East Fork Cooperative partners, is a 10-foot wide, 400-foot long bed that is two feet deep, layered with

Installation of submerged vegetated bed outlet structure.

Placement of gravel in submerged vegetated bed.

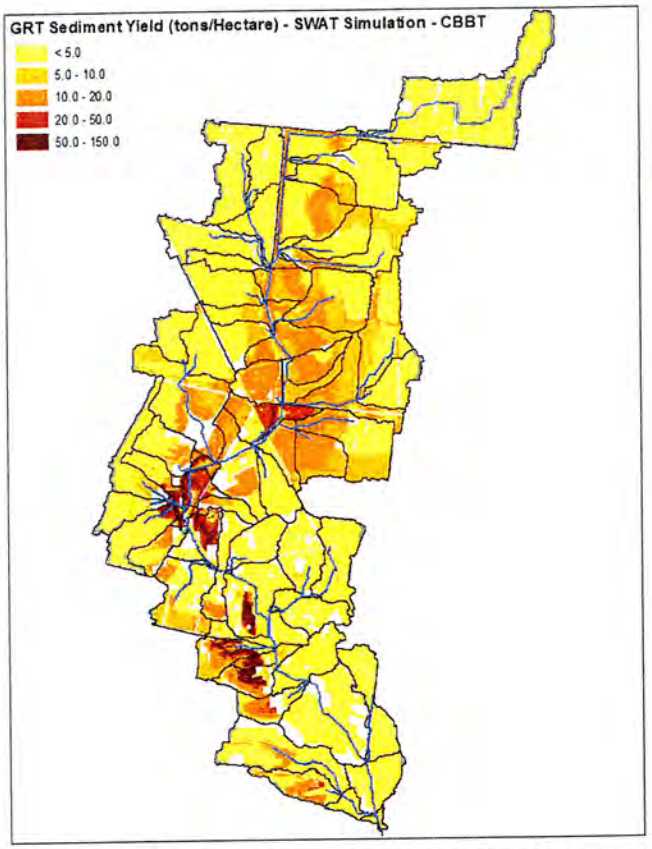
AgBMP detention structure after a summer storm.

Clermont SWCD leads Ohio EPA staff on a tour of the submerged vegetated bed (bypass channel is seen at right).

three inches of AASHTO # 4 limestone, eighteen inches of AASHTO #8 limestone, and capped with another 3 inches of AASHTO #4 limestone. In total, the bed contains 350 tons of limestone. A thin layer of soil was placed on top of the limestone, and then planted with wetland species of plants, including four species of sedge (Carex), four species of rushes (Scirpus), a species of rush (Juncus), along with Blue Flag Iris for a splash of color in late spring. Water from the detention basin enters the SVB at the bottom through a perforated pipe that spans the width of the bed, allowing for the water to be dispersed evenly. At the far end of the bed, the outlet is positioned on top of the rock within the SVB to provide retention time allowing for the creation of anoxic conditions.

Monitoring of the SVB began in December 2014; however, it wasn't until September 2015 that all monitoring stations were completely operational. Monitoring stations with flow meters and automatic samplers and have been installed at four critical locations, including the point of inflow into the detention basin, the inflow point into the SVB, the SVB effluent, and at the end of the bypass channel. The four monitoring stations record stage and rainfall (at one site) every five minutes. Discharge measurements have been used to develop rating curves for the two open channel sites (inflow to the detention basin and the bypass effluent), while area-velocity meters are used to calculate discharge in the piped locations (SVB influent and effluent). Discharge data will be used to calculate pollutant loads entering and leaving the system. Flow or time paced wet weather sampling and ambient sampling occurs at all four locations. Samples are collected using four ISCO autosamplers. Samples are analyzed for orthophosphate, total phosphorus, ammonia, nitrate-nitrite, TKN, suspended solids and a suite of pesticides including atrazine, simazine, alachlor and glyphosate.

Because the project team has collected less than two years of monitoring data, we have not determined the effectiveness of the capture system in reducing nutrient loads; however, initial data show that there has been a significant reduction in phosphorus in the detention basin and that the SVB has been effective in removing nitrogen. Sampling efforts will continue over coming years to more completely determine the success of the project.



SWAT model simulation shows predicted annual sediment yield for Grassy Fork watershed.

SWAT model simulation shows areas of high sediment yields. The highlighted fields were targeted for cover crops.

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